United States
Department of
Agriculture

Animal and
Plant Health
Inspection
Service

Plant Protection
and Quarantine

Cooperating State
Departments of
Agriculture

September 1984

ACTION PLAN

CABBAGE MOTH
Mamestra brassicae (Linnaeus)

This PPQ Action Plan or New Pest Response Guideline has not been updated since its publication date. The actions or guidelines recommended may not be appropriate now, new survey tools may be available, and chemical pesticides named may no longer be registered. This documents is posted until updated versions can be drafted and as such are only guidelines that represent the state of knowledge at the time they were written. Please consult PPQ and/or your State Plant Regulatory Official prior to implementing any recommendations listed herein.

INDEX

AUTHORIZATION

This Action Plan provides guidelines and actions for the eradication of a cabbage moth infestation. This Action Plan supplements information contained in the Plant Protection and Quarantine (PPQ) Treatment, Emergency Programs, and Administrative Procedures Manuals.

It is to be used in conjunction with other manuals when conducting emergency program activities. The information and instructions contained in this Action Plan were developed with and approved by representatives of cooperating States, the U.S. Department of Agriculture's Agricultural Research and Cooperative State Research Services, and affected industry.

All program technology and methodology employed are determined through discussion, consultation, or agreement with the cooperating State officials.

NOTICE

Recommendations in this Action Plan, which involve the use of pesticides, concern products which are registered or exempted under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended. Precautions on the pesticide label and all instructions in this Action Plan must be carefully followed.

Federal and/or State personnel may not make any warranty or representations, expressed or implied, concerning the use of these products and shall not be responsible for any loss, damage, or injury sustained as a result of the use of any product as specified in this Action Plan.

The use of trade names in this Action Plan does not imply an endorsement of those products or of the manufacturers thereof by Federal-State pest control programs. Equivalent formulations under different trade names are acceptable.

H. L. Ford
Deputy Administrator
Plant Protection and Quarantine

8/14/84
Date

H. B. Jackson
Chairman
National Plant Board

8/14/84
Date

I. GENERAL INFORMATION

A. Action Statement

The information contained in this document is intended for use when a cabbage moth infestation is known to exist. This Action Plan is to be used for guidance in implementing eradication procedures and in preventing spread to other locations. It provides technical and general information needed to implement any phase of a cabbage moth eradication program. Specific program action is to be based on information available at that time.

B. Background Information

The cabbage moth family, also known as cabbage armyworm, is native to Eurasia. This noctuid moth occurs all the way from the British Isles, Spain, and North Africa to Siberia, Japan, and China. It is recorded from 45 known hosts plus unspecified hosts in 17 additional genera. It is frequently intercepted on leaves and flowers from Europe and Asia, commonly on cabbage, cauliflower, and turnip, and on flowers of various kinds. This pest prefers a number of important hosts, including crucifers, beets, corn, carnations, chrysanthemums, clover, cotton, hemp, grapes, onions, peas, soybean, and tobacco. Injury results from eating the leaves and young shoots, boring into stalks and fruit, or, in the case of crucifers, boring into and eating the head, leaving masses of frass which makes it unfit for human consumption.

Development from egg to adult at an optimum temperature of 22.4° C. (74.1° F.), nights no greater nor less than 8 to 9 hours (days 15 to 16 hours) during larval development and 60 to 80 percent relative humidity takes approximately 39 days. The adult becomes sexually mature after 2 days (3 nights) at most, and one generation requires 41 days under these conditions. Summer diapause of early pupae and winter diapause of fall pupae result in late spring-early summer, late summer-early fall populational peaks of larvae in a given year. It is likely this species can exist in any of the United States.

C. Life Cycle Application

Insect development is temperature dependent. The egg, larval, and adult reproductive development is influenced by air temperatures; pupal development depends on surface soil temperatures. In both environments, a minimum temperature exists below which no measurable development takes place. For cabbage moth, this threshold is 8.6° C. (47.5° F.) in air. A temperature model that is designed to use modified air temperature data for all life stages can be used to predict the entire life cycle. The number of degrees accumulated above the developmental threshold for a life stage are referred to as day degrees. For the model depicted in the table below, 299.5° C. (571.1° F.) day degrees must be accumulated before one life cycle has been completed.

Formula:

Minimum Daily		Maximum Daily		Total		Average Daily		Threshold		Day Degrees
Temp ^{o} F.	+	Temp ^{o} F.	=	$\frac{\text{Temp } ^{o} \text{ F.}}{2}$	=	Temp ^{o} F.	-	Temp ^{o} F.	=	Temp ^{o} F.

Example: (Air model using a 47.5^{o} F. (8.6^{o} C.) threshold limit.)

Minimum Daily		Maximum Daily		Total		Average Daily		Threshold		Day Degree
59^{o} F.	+	64.4^{o} F.	=	$\frac{123.4^{o} \text{ F.}}{2}$	=	61.7^{o} F.	-	47.5^{o} F.	=	14.2^{o} F.

While the model above may be used for nondiapausing and overwintering pupae, it is not applicable for pupae in summer diapause. In this case and also as a running check on nondiapausing pupae, daily temperature readings should be taken and averaged at 5-day intervals (in 1-day increments) until that average drops down to 20 to 24^{o}C. (68 to 75.2^{o} F.). at which time emergence takes place.

Program actions are guided in part by the insect life cycle data. Duration and timing of eradication treatments, length and frequency of trapping activities, and regulatory functions are affected primarily by the length of time it takes to complete each stage of the life cycle. Temperature data are available from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, private, State, university, or industry sources, or can be generated by strategically placing thermometers on the soil surface.

II. SURVEY PROCEDURES

A. Delimiting Survey

1. There are two primary delimiting survey systems which must be used to complement each other if a cabbage moth infestation is to be adequately delimited.

When one or more cabbage moths are collected in an area, a delimiting survey will be implemented immediately to determine the population distribution.

a. Trap

Using the site of the detection as the focal point (epicenter), 14 tetra traps per square mile (i.e., Albany International's Scentry Delta trap with upper flaps out or an equivalent) will be set out in a core area of 4 square kilometers (sq km) (1.54 sq mile (mi)) in host fields with a bias for preferred hosts, otherwise adhering to a standard grid array. The traps are baited with Z-11-16 AC and serviced every 2 weeks. Place traps in or near hosts. Traps will be maintained through three cabbage moth generations after the last find. To maximize the survey effort, traps should be deployed April (or date of first emergence) through October of any given year.

b. Visual

Using the site of the detection as the focal point (epicenter), locate suitable host fields within each km of the core. Up to 100 hectares (ha) (approximately 250 acres (a)) of host, if available, are to be surveyed in the core. This will include 20 ha (50 a) in each sq km and in the epicenter where the find was made or nearest feasible host field. Each field will be sampled at five locations in three rows of host. A minimum of 50 plants will be examined for the presence of eggs under leaves and larvae on leaves as given in Addenda D and F. Inspect fruit, stems, young shoots, flowers nibbled from the rim inwards, or heads as indicated by nibbled undersides of leaves, holes in leaves (leaving only main ribs) gnawed tips or holes in fruit, or heads as given in Addenda D and F.

To maximize the survey effort, the activity should be correlated with climatic factors and insect development.

The visual survey will be repeated once a week, in alternate host fields, if possible, for at least three cabbage moth generations. It will be rotated to allow coverage of the entire core area over a 4-week period.

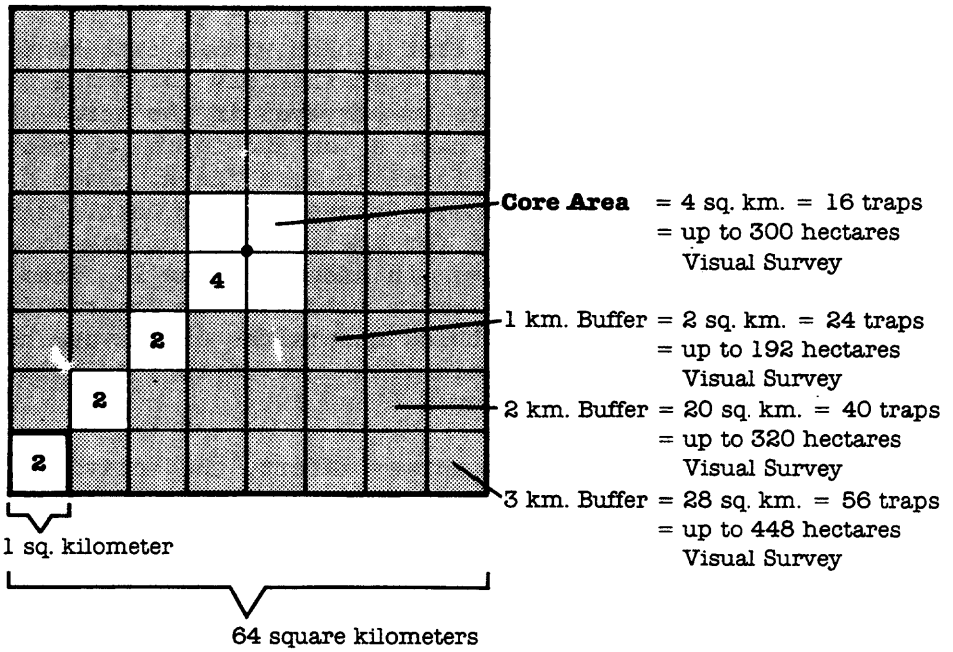
2. The extent of survey operations is given as follows:

a. If only one insect (any stage) is detected, the delimiting survey is limited to the 4-sq-km (1.54-sq-mi) core area.

b. If two or more detections are made within a 4-sq-km (1.54-sq-km) area, the delimiting survey will be conducted over 36 sq km (about 14 sq mi). Traps will be deployed in the core and buffer areas at the rate of 14 per sq km. A larval survey will also be completed in the core areas and the first and second buffers, the latter at the rate of a minimum of 16 hectares (approximately 40 acres) per sq km (approximately 100 per sq mi).

c. If six or more detections are made in an area involving 16 sq km (6 sq mi) or more, the delimiting survey will be conducted over a 64-sq-km (25-sq-mi) area. Traps will be deployed in the core and buffer areas 1, 2, 3 km as in 2a and b above. A larval survey will also be carried out as in 2a and b.

Survey Per Square Kilometer



As an optional supplement, light traps may be used near each detection and at selected locations in the core and buffer areas where large numbers of hosts are found.

B. Monitoring/Evaluation Survey

A monitoring/evaluation survey will be conducted in that area where eradication treatments are applied. The traps and visual survey systems are maintained at the delimiting rate.

C. Host Collection and Holding

Selected hosts (fruit, shoots, stems, heads with young--first to third instar larvae and leaves with eggs) that are collected will be held at temperatures and humidity which will permit insect development to the point where a positive determination can be made.

The facility where the hosts are held must be secure to prevent any inadvertent release of moths. Security measures must be equal to those established for a quarantine insect-rearing facility. See Animal and Plant Health Inspection Service 81-61 for detailed information.

D. Soil Screening

Passing of soil through a screen for the detection of pupae (see Addendum F). Soil samples will be collected within 200 meters (m) (216 yards (yd)) of a larval or egg detection. Any recovered pupae will be held at developmental temperatures and a light period between 14 to 16 hours that avoids or breaks diapause and leads to completion of adult development.

E. Detection Survey

The area beyond the last buffer zone will be trapped at a minimum rate of four traps per square kilometer (nine traps per sq mi) for two life cycles where hosts are available up to 16 km (10 mi) from the epicenter. A visual survey of at least three 4-ha (10-a) fields per 8 sq km (one field per sq mi) will also be continued in this area for two life cycles.

F. Orientation of Survey Personnel

New personnel will be trained, on the job, by experienced personnel. It will be necessary to have 3 working days to teach the many facets of the cabbage moth survey.

G. Survey Records

Records noting the areas surveyed, sites trapped, dates, locations, and hosts in which detections were made will be maintained (see Addendum G).

III. REGULATORY PROCEDURES

A. Instructions to Officers

Regulatory actions will be required until the pest is eradicated. Officers must follow instructions for regulatory treatments or other procedures when authorizing the movement of regulated articles. Understanding the instructions and procedures will serve as a basis for explaining such procedures to persons interested in moving articles affected by the quarantine and regulations. Only authorized treatment procedures may be used.

General instructions that are to be followed in regulatory treatments are found in the PPQ Treatment Manual.

Officers may aid shippers in selecting the authorized treatment or procedure that is most practical for the shippers. They should advise the shipper to apply selected treatments to small quantities of material prior to treating larger quantities to determine the reaction or effects of the treatment procedure. When treating commodities, which are particularly sensitive to the treatments selected, treat more of the commodity than is needed to allow for possible losses.

B. Regulated Articles

1. Any part of the following:

Common Name	Scientific Name
Alstromeria	*Alstromeria* spp.
Apple	*Malus sylvestris*
Aztec tobacco	*Nicotiana rustica*
Bean	*Vigna* spp.
Beet	*Beta vulgaris*
Birch	*Betula* spp.
Bleeding heart	*Dicentra spectabilis*
Broccoli	*Brassica oleracea* var. *italica*
Buckwheat	*Polygonum convolvulus*
Cabbage	*Brassica oleracea* var. *capitata*
Chinese cabbage	*Brassica rapa* var. *pekinensis*
Chinese rhubarb	*Rheum palmatum*
Carnation	*Dianthus* spp.
Carrot	*Daucus carota*
Castor bean	*Ricinus communis*
Cauliflower	*Brassica oleracea* var. *botrytis*
Celery	*Apium graveolens* var. *dulce*
Chrysanthemum	*Chrysanthemum* spp.
Clover	*Trifolium* spp.
Colville's glory	*Colvillea racemosa*
Corn	*Zea mays*
Cotton	*Gossypium hirsutum*
Cotton groundsel	*Senecia viscosus*

Dahlia	Dahlia spp.
Deadly nightshade	Atropa belladonna
Eggplant	Solanum melongena
Endive	Cichorium endiva
Fireweed	Epilobium spp.
Flax	Linum usitatissimum
Garlic	Allium sativum
Geranium	Geranium spp.
Gladiolus	Gladiolus spp.
Goldenrod	Solidago spp.
Grapes	Vitis vinifera
Hemp	Cannabis sativa
Knapweed	Centaurea spp.
Lamb's-quarters	Chenopodium album
Lettuce	Lactuca sativa
Lupine	Lupinus spp.
Onion	Allium cepa
Opium poppy	Papaver somniferum
Pea	Pisum sativum
Peanut	Arachis hypogaea
Peppermint	Mentha x piperita
Potato	Solanum tuberosum
Pot-marigold	Calendula officinalis
Pyrethrums	Pyrethrum spp.
Rape	Brassica rapa
Redroot pigweed	Amaranthus retoflexus
Safflower	Carthamus tinctorius
Savory	Satureja spp.
Savoy cabbage	Brassica oleracea var. bullata
Sea-lavender	Limonium spp.
Sesame	Sesamum indicum
Soybean	Glycine max
Spirea	Spiraea spp.
Sunflower	Helianthus annuus
Tobacco	Nicotiana tabacum
Tomato	Lycopersicon esculentum
Turnip	Brassica rapa
Vetch	Vicia sativa
Yellow sweet clover	Melilotus officialis

2. Soil within the drip area of plants which produce the fruits, flowers, or vegetables listed above.

3. Any other product, article, or means of conveyance, of any character whatsoever, when it is determined by an inspector that they present a hazard of spread of cabbage moth and the person in possession thereof has been so notified.

C. Quarantine Actions

When detections are made, the following steps should be implemented in sequence:

1. With the detection site considered the epicenter, all growers and establishments that grow, handle, move, or process regulated articles within a minimum of 3 linear km (approximately 1.86 mi) will be issued emergency action notifications requiring treatment or other approved handling procedures. Emergency Action Notifications (PPQ Form 523) and/or comparable State notifications are issued by field personnel to the property owners or managers of all establishments who grow, handle, move, or process articles capable of spreading the cabbage moth. A notification will be issued pending authoritative confirmation and/or further instruction from the Deputy Administrator.

2. If necessary, the Deputy Administrator will issue a letter directing PPQ field offices to initiate specific emergency action under the Federal Plant Pest Act (7 U.S.C. 150dd) until emergency regulations can be published in the Federal Register.

The Federal Plant Pest Act of 1957 provides for authority for emergency quarantine action. This provision is for interstate regulatory action only; intrastate regulatory action is provided under State authority. However, if the Secretary of Agriculture determines that an extraordinary emergency exists and that the measures taken by the State are inadequate, USDA can take intrastate regulatory action provided that the Governor of the State has been consulted and a notice has been published in the Federal Register.

The Organic Act of 1944, as amended, provides the Federal Government, either independently or in cooperation with States or political subdivisions thereof, farmers' associations and similar organizations, and individuals, the authority to carry out operations or measures to detect, eradicate, suppress, control, or to prevent or retard the spread of plant pests. This Act does not provide for trespassing on private property, but relies upon State authority and willingness to use State right-of-entry authority.

All program technology and methodology employed are determined through discussion, consultation, or agreement with the cooperating State officials.

3. The Deputy Administrator, through the National Regional Directors, will notify State cooperators of the cabbage moth detection, actions taken, and actions contemplated.

A narrative description of the regulated area with support documents will be developed by USDA and cooperators and provided to the Regulatory Services Staff, National Program Planning Staff (NPPS). The regulated area will also be defined by the Universal Transverse Mecator grid marking system for use by the Project Manager.

4. APHIS Regulatory Coordination Staff will publish in the Federal Register emergency regulations under the Federal Plant Pest Act.

5. After a reasonable time, taking into consideration such factors as the biology of the pest, climatic conditions, and infestation spread, a proposal to promulgate a quarantine under the Plant Quarantine Act will be published. The proposal will announce a date for submitting written comments, which shall be approximately 60 days after publication.

6. After receipt of written comments a final determination specifying the action decided upon will be published in the Federal Register. If after consideration of the comments a quarantine is warranted, it would be invoked under the Plant Quarantine Act.

D. Regulated Establishments Inspection

Efforts to detect the pest within the regulated area will be made at all establishments where regulated articles are grown, handled, moved, or processed. Establishments that might be involved are: Airports, landfill sites, processing plants, farmers', produce, and flea markets, nurseries, flower shops, and any other establishments that handle regulated articles. Two tetra traps per establishment will be set and serviced weekly if trap catches of insects are high or biweekly if trap catches are low.

E. Use of Authorized Chemicals

The PPQ Treatment Manual and this Action Plan contain the authorized chemicals, methods and rates of application, and any special application instruction. Concurrence by the PPQ's Survey and Emergency Response Staff (SERS) is necessary for the use of any chemical or procedure for regulatory purposes.

F. Approved Regulatory Treatments

1. Fumigation. The application of an approved fumigant as a treatment alone or in conjunction with cold treatment procedures.

2. Cold Treatment. The use of cold temperatures as a treatment on selected products alone or in conjunction with fumigation procedures.

3. Sanitation. The removal and destruction of leaves, flowers, stems, stalks, rotting or fallen fruit, vegetables, and other host material.

4. Steam Sterilization. The use of live steam as a treatment alone.

5. Soil Treatment. An approved insecticide applied to the soil within the drip line of host plants. All fruit to be removed from all host plants and plants held for one life cycle after treatment before certification.

G. Principal Activities

The following identifies principal activities necessary for conducting a regulatory program to prevent the spread of cabbage moth. The extent of regulatory activity required is dependent on the degree of infestation. For example, safeguarding vegetable stands throughout the entire regulated area which are engaged in only local retail activity may not be necessary when the regulations that are imposed are based on a limited and light infestation. Manadatory checks of passenger baggage (i.e., for vegetables) at airports and the judicious use of road patrols and roadblocks may be necessary where general or heavy infestations occur.

1. Advising regulated industry of required treatment procedures.

2. Supervising, monitoring, and certifying commodity treatments of commercial lots of regulated articles.

3. Contact visits with:

   a. Security and airline personnel.
   b. Vegetable stands.
   c. Flower stands.
   d. Local growers, packers, and processing plants.
   e. Farmers', produce, and flea markets.
   f. Commercial haulers of regulated articles.
   g. Public transportation.

4. Visiting canneries and other processing establishments.

5. Monitoring the movement of waste material to and from landfills to ensure adequate disposal of regulated article refuse.

6. Monitoring the movement of regulated articles through major airports and other transportation centers.

7. Movement of host material along major highways and across quarantine boundaries.

H. Orientation of Regulatory Personnel

Only trained or experienced personnel will be used initially. Replacement personnel will be trained by the individual being replaced. A training period of 3 working days is necessary for the orderly transfer of these functions.

I. Regulatory Records

Records will be maintained, as necessary, to carry out an effective, efficient, and responsible regulatory program (see Addendum G).

IV. ERADICATION PROCEDURES

Surveys and Emergency Response Staff, in consultation with methods and research agencies, outlines treatments to be used and must be notified of all treatment plans. If treatments selected or proposed are not in conformance with current pesticide labels, an emergency exemption may be provided under Section 18 of the FIFRA, as amended. For further instructions, see Emergency Programs Manual, Section V, B.

Eradication of a cabbage moth infestation is essential. Local conditions will determine the most acceptable procedure to achieve eradication.

A. Recommended Pesticides

1. Carbaryl
2. Acephate
3. Chlorpyrifos
4. Trichlorfon
5. Methomyl

Data on related species indicate that alternative insecticides may be equally or more effective. At the initiation of a program, an evaluation of other available insecticides for use on program operations will be made.

B. Approved Eradication Treatments

1. Ground Spray

Ground application of insecticide will be initiated immediately. All host plants which provide for reproduction of the cabbage moth on the infested property, adjacent property, and within 200 m (216 yd) of the known infestation will be sprayed at the prescribed intervals if host material is scattered or infestation is light. Spraying may be extended to cover adjacent properties if they have substantial host material. Ground application in large infestations will be applied to host material to a minimum of 3 linear km (1.86 mi) beyond any known infestation. Ground spraying may be discontinued after an estimated two generations of negative survey or after the initiation of aerial treatment.

2. Aerial Spray

Aerial application of insecticide should be initiated immediately. Aerial spray will be applied when and where ground treatment is not practical. Application will be made at the prescribed intervals over a minimum period equal to two life cycles after the last find. The number of applications will vary depending on the estimated day degree accumulations or predicted emergence periods in the infested area. The area to be sprayed will extend a minimum of 3 linear km (1.86 mi) beyond any known infestation.

Weather conditions may dictate changes in spray schedule. After an estimated two generations of negative trapping and survey, spray operations may be discontinued.

The decision to apply insecticide applications will be based on the best weather information available. In the event rain washes an application from the foliage, plans will be implemented to retreat the area.

Retreatment should not be considered if weather reports indicate 50-percent or greater chance of precipitation in the 48-hour period following washoff.

The objectives are to eradicate the pest and minimize environmental contamination. Any treatment or retreatment recommendation must consider these objectives.

3. Supplemental Methods

a. Sanitation: Sanitation in nurseries, farms, gardens, and other establishments where hosts are present will be carried out within the core and buffer areas.

b. Host Destruction: In situations with a very limited area of infestation, consideration will be given to the destruction of host by (1) herbicides, (2) disking or plowing, and (3) removal and burial or incineration. In cases of such destruction, all host material must be completely destroyed.

c. Plowing: Thorough plowing and disking of host fields to expose pupae to weather and predation after fall harvest may be required.

d. Fruit and Head Stripping: Properties with caterpillars in the fruit or heads, etc. of host plants will be handled as in 1 or 2 above. In addition, all preferred host fruit or heads within 200 m (216 yd) of the larval site may be stripped, if practical.

C. Eradication/ Control Method Selection

The following parameters or criteria will determine the minimum treatments to be used in achieving eradication. Expanded or additional treatment actions can be applied if mutually agreed upon by cooperating agencies.

Eradication measures will continue for at least two generations and trapping will continue for at least three generations following the last detection.

1. If one adult male or one unmated adult female is detected, no eradication treatments will be initiated.

2. When one to five mated females, larvae, or pupae, or two to five males/unmated females are detected in an area of less than 16 sq km (6 sq mi), sanitation, host destruction, wild host clearance, fruit/head stripping, and ground applied foliar sprays will be employed and extend 200 m (216 yd) beyond any known infestation. Similar detections in a commercial production area will require treatment by sanitation, host destruction, wild host clearance, fruit/head stripping, and ground or aerial sprays, as applicable.

3. When more than six of any stage(s) are detected in an area greater than 16 sq km (6 sq mi), ground and aerial applications will be employed and include and extend 3 km (1.86 mi) beyond any known infestation. Sanitation, wild host clearance, fruit/head stripping, and host destruction will only be employed adjacent to finds and where practical. Plowing will be carried out in commercial production areas.

The minimum treatments prescribed are predicated on an adequate survey.

D. Orientation of Eradication/Control Personnel

Only trained and experienced personnel will be utilized initially. Replacement personnel will be trained by the individual being replaced. A period of 3 working days is necessary for the orderly transfer of these functions.

E. Eradication/Control Records

Records noting the location of detection, dates, number and type of treatments, and materials and formulations used will be maintained for all areas treated (see Addendum G).

F. Monitoring

An effective monitoring program will be implemented to aid in the evaluation of program efforts and environmental impact. The application and use of insecticides and other controlled substances will be assessed through the use of appropriate monitoring program criteria. The evaluation must effectively address Agency, cooperator, and public concerns.

The monitoring program will include at least the following elements:

1. Determine efficacy of the pesticide against the target pest.

2. Evaluation of dye cards to monitor aerial application.

   a. Droplet size information.
   b. Droplet distribution information.
   c. Identification of wind drift components.
   d. Verification of spray block boundaries.
   e. Identification of skips.

3. Sampling to evaluate effect on environmental components.

   a. Water sampling to detect insecticide levels through direct application, leaching, and runoff.
   b. Soil sampling to determine insecticide levels and residues.
   c. Foliage sampling to identify residues.
   d. Biological organism sampling during applications and posttreatments to determine impact of pesticides.
   e. Air sampling to determine presence of pesticides in respirable air.

The monitoring program is to be a combined effort between the State in which the emergency program is being conducted and PPQ. If specific plans need to be developed for monitoring activities, Survey and Emergency Response Staff will request assistance and guidelines from other NPPS staffs.

V. CONTACTS

When a cabbage moth eradication program has been implemented, its success will depend upon the voluntary cooperation, assistance, and understanding from other involved groups. The following is a list of groups which either are involved in or must be kept informed of all operational phases of an emergency program.

A. Other Federal, State, county, and municipal agricultural officials

B. Grower groups

C. Commercial interests

D. Universities

E. Florist groups

F. State and local law enforcement officials

G. Public health agencies

H. Foreign agricultural interests

I. National, State, and local news media

J. General public

VI. ADDENDA

Addendum A--Definitions

Aerial Treatment:	Applying an insecticide by aircraft over a treatment area.
Array:	The trapping pattern in a 1-sq-km (0.39-sq-mi) area.
Buffer Area:	The area extending beyond the boundary of the core--1-km, 2-km, and 3-km (0.6-, 1.24-, and 1.86-mi) buffer.
Cold Treatment:	The use of cold temperatures as a treatment on selected products alone or in conjunction with fumigation procedures.
Commercial Production Area:	An area where host material is grown for distribution.
Confirmed Detection:	A positive identification by a recognized expert of a submitted life form (specimen) as cabbage moth.
Core Area:	A minimum distance of 1 km (0.62 mi) beyond any confirmed cabbage moth detection.
Day Degrees:	The accumulation of heat units above a specified developmental temperature threshold during a life stage.
Delimiting Survey:	Determining the extent of the infestation in an area where cabbage moth has been detected.
Detection:	The collection of any life stage of cabbage moth.
Detection Survey:	An activity conducted in a susceptible area not known to be infested with cabbage moth.
Epicenter/Focal Point:	The initial site of an infestation.
Fumigation:	The application of an approved fumigant as a treatment (methyl bromide) alone or in conjunction with cold treatment procedures.
Generation: (Life Cycle)	The period of time for the pest to complete all stages of development predicated on day degrees or on the basis of other biological information.
Ground Spray:	Using ground spray equipment to apply an insecticide to host vegetation in a cabbage moth infested area.

Host:	A plant species that provides the potential for reproduction of the cabbage moth.
Host Collection/ Holding Survey:	Collection and holding of host material to determine the extent and nature of an infestation.
Infestation:	The collection of two or more cabbage moths, a pupa, a larva, or mated female from an area or the detection of a single adult determined to be associated with a current infestation.
Infested Area:	Three kilometers distance from all detection sites unless biological factors indicate the need for more or less area.
Mamestra brassicae: (Linnaeus)	The scientific name of the cabbage moth.
Monitoring/Evaluation Survey:	Using interdependent visual and trapping surveys conducted in an area where an insecticide treatment has been applied to evaluate the effectiveness of the application.
PPQ-APHIS-USDA:	Plant Protection and Quarantine, Animal and Plant Health Inspection Service, United States Department of Agriculture.
Regulated Area:	An area that extends at least 3 linear km (1.86 linear mi) in any direction from an infested property.
Regulatory Inspection:	Visual examination of host material and containers plus discretionary trapping conducted around establishments where regulated articles are grown, handled, processed, or moved.
Soil Treatment:	The application of an approved insecticide to the soil of nursery stock and within the drip line of host plants.
Summer Diapause:	A resting period or aestivation triggered by short nights (8 hours or less) and terminated when summer temperatures drop to 68° to 75.2° F. (20° to 23° C.) on a 5-day average.
Tetra Trap:	A disposable, sticky-coated trap used primarily for lepidopterous insects—a modified Delta trap.

Trap Survey:	Determining the presence or absence of a pest by the use of traps and an attractant placed in a predetermined pattern and serviced on a given schedule.
Visual Survey:	Examining hosts for eggs, larvae, and cocoons, either in the field or in regulated establishments, or in monitoring the movement of regulated articles.
Winter Diapause:	A condition of suspended animation during cold months, triggered by long nights (10 hours or more) and ending in spring as measured by day degrees.
Z-11-16 AC:	The chemical designation for the sex pheromone for cabbage moth.

Addendum B--Safety

Personnel and public safety must be prime considerations at all times. Safety practices should be stressed in preprogram planning. Supervisors must enforce on-the-job safety procedures. For complete instructions, see V, D, in the Emergency Programs Manual.

Addendum D--Life History

1. SYSTEMATIC POSITION

Cabbage moth, Mamestra brassicae (Linnaeus), (Lepidoptera, Noctuidae)

Class: Insecta
Order: Lepidoptera
Family: Noctuidae

There are only three species in this genus as it now stands. It is holoartic, ranging down to the Mediterranean, China, Japan, and North America, but does not occur in tropical areas or in the Southern Hemisphere. Related species are:

Mamestra configurata Walker
Mamestra curialis Sm.

M. configurata, the bertha armyworm, is a well known pest. M curialis, the spined rustic, is a minor pest of flowers such as marigolds. Both species occur in this country.

2. IDENTIFICATION CHARACTERS

Some preidentification and sorting needs can be met by personnel assigned to the program.

The cabbage moth adult can generally be described as a small, blotchy brown to grey moth with white marks about 18.5 mm (0.73 in) long and 5 mm (0.2 in) wide and with a wing expanse of 44 mm (1.73 in). The forewings are grey, brown, or black with vague patterns and streaks with a narrow subterminal line. This contrasts with a broad subterminal line found in the two species of Mamestra in North America. In overall appearance, the other two species are uniformly darker. The two identification characters just cited are best utilized with a series of specimens of all three species available for comparison.

The genus Mamestra can be identified by picking out moths fitting the above description and then checking to ascertain that they have a combination of hairy eyes and a strong claw at the apex of the tibia of each leg.

The larvae of Mamestra can generally be identified by the markings on top. These consist of three light lines and slanting black marks on each segment. It is harder to separate cabbage moth from the two native species. M. curialis is restricted to the Western States and has a comparatively short, thick spinneret, that of cabbage moth is slender and elongate. M. configurata has several sclerites or plates in front of the dorsal setae and is restricted to the Eastern States. Both cabbage moth and M. curialis lack this feature.

Figure 1—Identification of *Mamestra brassicae*

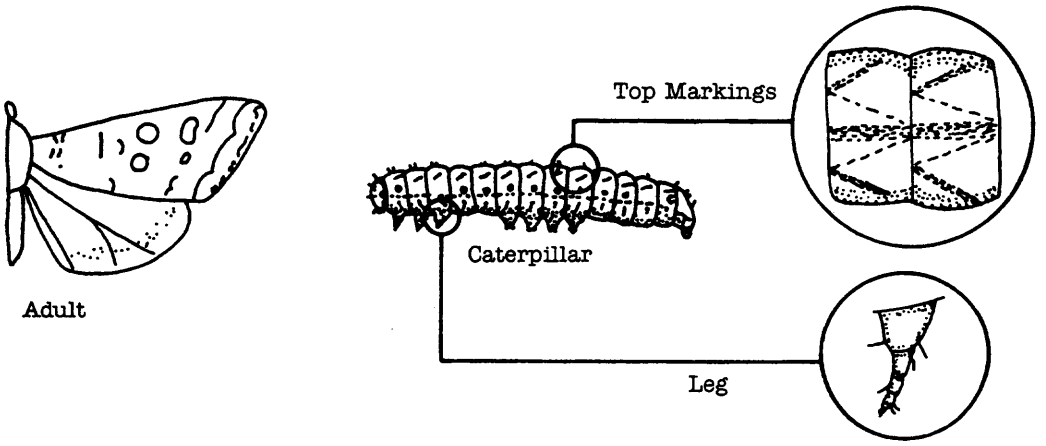
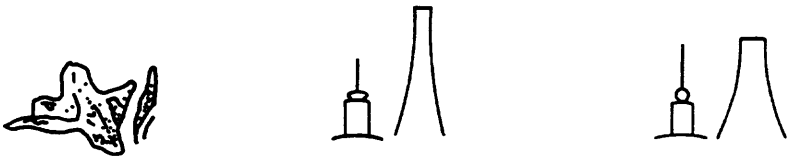


Figure 2—Distinguishing Characteristics of *Mamestra*



Eggs: About 0.5 mm (0.02 in) in diameter, flat at base, otherwise spheroid, at first a light-yellow, than turning to deep brown in color, with contrasting stripe or rib on sides joining together at a brown knob on the top of the egg.

Larvae: First instar very small (about 1.5 mm (0.06 in) in length), recognizably a caterpillar with a greenish body.

Subsequent instars change to dark green, greenish-grey, or yellowish-brown with more or less distinct longitudinal stripes. If four to six instars are not subject to crowding, the greenish coloration is retained (solitary phase). If, however, crowding occurs, varying shades of dark grey, brown or black develops, the number of individuals and intensity of change involved is dependent on the density of population. Body otherwise marked with a dusty central line speckled with white on dorsal surface and a lateral yellow or light-green stripe on each segment.

Mature (sixth instar) larvae about 30 mm (1.18 in) long (large individuals may be 40 to 60 mm (1.58 to 2.36 in) long), with three light lines and slanting black marks on each segment, except last, which has a pattern of bright colors, these deeper in anterior half. Head varying from yellow with a slight tinge of brown to brilliant black, surface horny. Behind head, the first segment is blackish and last segment prolonged on ventral side between the last pair of prolegs. Legs and prolegs green; spiracles pure white, except for dark area behind each spiracle, spinnerets slender. Body surface smooth with few hairs.

Pupae: (Chrysalis) — Short, stout, 22 to 23 mm (0.87 to 0.91 in) in length, body a deep chestnut to glossy brown in color.

Adults: — Body approximately 18.5 mm (0.73 in) long and 4.45 mm (0.18 in) wide, forewings approximately 44 mm (1.73 in) when spread. Overall appearance, a dark, blotchy grey to black with white markings. Forewings grey, brown, or black with many vague blackish streaks and marks present. Kidney-shaped mark distinct and with white outline, irregular white transverse line near margin, pale at base; subterminal line on inner side, narrow, not defined by whitish area, orbicular spot distinctly defined by black. Hind wings are brown, pale at base with a whitish fringe. Otherwise, very variable in coloration. Eyes hairy, thorax same color as forewings, abdomen brown with more or less distinct tufts of hair down back, tip distinctly tufted, legs brown and very hairy at base, fore tibiae with long, terminal claw.

3. BIOLOGY

A mated female moth flies at night from dusk to dawn. Egg laying takes place in the early hours of the morning about 2 to 3 a.m. and occurs very quickly on the underside of leaves of the chosen host. They are laid in rows, which then form clusters of 15 to 188 eggs, covering up to a square centimeter of leaf surface area. Sometimes up to 1,400 eggs may be laid in a single cluster. The female may lay from several hundred up to 2,500 eggs, usually in 2 to 5 nights, but occasionally extending up to 16 nights. Each female lays from 2 to 11 clusters. There are two or three generations a year, with little overlapping. In colder areas, only one generation is completed. It is possible for only part of a subsequent generation to be caught by cold weather, resulting in substantial mortality of caterpillars not in the final instar and unable to pupate. The incubation period is 2 days under optimum conditions (22.4° C./74.1° F.) and more normally 4 to 12 days, sometimes up to 16 days under normal developmental conditions ranging from 12.6° to 28.3° C. (54.7° F. to 82.9° F.).

After hatch, the young larvae are gregarious and remain in groups on the underside of leaves. They are most active in late afternoon until midnight and consume the epidermal layer and underlying parts of the leaves, leaving the upper side intact. After the second instar, they disperse from one leaf to another or one host to another, remaining generally on the underside of the leaves. As they grow, they perforate the leaves more and more, eating up the whole leaf, except for the largest veins. Some cannibalism takes place under crowded conditions, particularly of eggs. Late in the fifth and certainly in the sixth instar, the larvae look for shelter from daylight. Feeding also shifts to become a clearly nocturnal activity by the sixth instar. It is at this point that the damage becomes really important.

Under crowded conditions, the fourth to sixth instars not only change color, but development time is decreased up to 11 percent less, with reductions in size and weight. There is a lower fat reserve and a corresponding intensification of metabolic processes. These "gregarious phase" larvae average 1 to 2 days less to complete their development.

In cabbage, larvae bore into heads or flowers. Three or four larvae can quickly render a head useless for consumption in a few nights. On other hosts, such as apple, these later instars tend to prefer the fruits to the leaves and will bore through the exocarp to the carpels, causing serious damage.

In any event, large amounts of frass accumulate inside and may extrude outside the bore hole. This frass also renders the fruit or head unmarketable. If the larvae are disturbed at any time, they will roll up into a ball and drop to the ground where they can remain for a long time.

If a host is stripped bare or, as can happen, a field of host(s) is entirely destroyed, the larvae may migrate en masse to nearby alternate hosts to complete development. In this way, a heavily infested field can be the source of sudden invasions into adjoining areas. Migration may also take place to or from wild hosts such as knapweeds, goldenrods, or lamb's-quarters.

The larval period lasts 16 to 32 days, at constant temperatures of 17° and 28° C. (62.6° and 82.4° F.) respectively, passing through six stages. The average duration of each stage at 17° C. (62.6° F.) is 4.75, 4.13, 3.96, 4.06, 4.4, and 11.17 days and at 28° C. (82.4° F.) it is 2.48, 2.17, 1.64, 1.98, 1.8, and 6.83 days. In the field, this period can vary from 22 to 41 days.

At the completion of development, the larvae leave the host and form pupae in the soil at depths of 2 to 15 cm. (0.79 to 5.91 in) These are sometimes surrounded by an earthen cell. At this point, further development is dependent on several factors. These are the hours of night the larvae were exposed to during the later stages of growth and the temperatures the pupae may experience and/or its accumulated development.

a. Summer Diapause

The early larvae of the overwintering generation, provided they experience short nights in early summer (May-June) of 8 hours or less and long days of 16 to 20 hours, will enter a summer diapause or aestivation lasting until late summer or early autumn (September-October), a period of about 2 to 3 months. Temperatures can have an influence. Low temperatures of 15° C. (59° F.) will result in only approximately 20 percent of pupae entering summer diapause, higher temperatures seem to increase percentage of diapausing pupae, and above 25° C. (77° F.) all are in diapause. This inactive period is broken when summer temperatures decrease to an average 5-day temperature span of 20° to 24° F. (68° to 75.2° C.).

b. Nondiapause

Late maturing larvae of the overwintering generation, encountering nighttime lengths of 8 to 9 hours or so (days of 15 to 16 hours), do not enter diapause. Instead they complete development in about a month (21 to 33 days, on average, 27 days). Diapause is broken by lower temperatures as above and these adults will emerge at roughly the same time as those which went through summer diapause.

c. Winter Diapause

The larvae of the second generation, experiencing long nights of 10 hours or more (short days of 8 to 14 hours), will enter a winter diapause or hibernation lasting until the following spring. This period is broken, when, as measured by day degrees, enough heat units accumulate to complete development.

Diapause is falculative and not obligatory. In Japan, high fall temperatures cause ecolsion of the pupae resulting in a third generation. This may abort due to cold weather. Most of the larvae will die from exposure, causing a population crash. Some may be able to complete development in comparatively warm climates and overwinter, thus completing that generation. Additionally, as in Denmark, the onset of cold weather may catch summer larvae before they can pupate, also resulting in a population crash.

The adults of the overwintering generation generally appear in May or June in Japan or Europe. The adults of the first generation appear in July, August, September, or October, depending on the location.

During the day, the moths hide under leaves, clods of soil, crevices in trees, at the base of thick trunks, stems, etc., in sheltered corners or in herbaceous growth. They lie flat with wings folded up over the body like a roof and are quite inconspicuous due to the color pattern of the wings and may easily be confused with the background. At night, especially on warm summer nights, from dusk to about 4 a.m., they gather on the flowers, flying very rapidly from one plant to another to feed on the nectar. Flight range, so far as is known, is believed to be local.

Maximum flight occurs at about 2 to 3 a.m. Mating takes place at this time. Individual coupling lasts for over 12 hours and can carry over until the following night. The preovipositional period does not exceed 48 hours. The adult life span is in excess of several weeks.

Generally, the total life cycle for cabbage moths, when the pupae does not experience diapause, is 41 to 88 days. With summer diapause, the life cycle can extend from 3 to nearly 5 months. Winter diapuase can extend 8 to 9 months in cold climates from August to April, which extends the life cycle for overwintering moths to 10 months or so.

Addendum C--Hosts

The cabbage moth hosts are listed by common and scientific names and are separated into preferred and other recorded hosts. In all instances, an attempt has been made to use the most widely recognized common name.

PREFERRED

Common Name	Scientific Name
Apple	*Malus sylvestris*
Beet (All varieties)	*Beta vulgaris*
Broccoli	*Brassica oleracea* var. *italica*
Cabbage	*Brassica oleracea* var. *capitata*
Carnation	*Dianthus* spp.
Cauliflower	*Brassica oleracea* var. *botrytis*
Chrysanthemum	*Chrysanthemum* spp.
Clover	*Trifolium* spp.
Corn	*Zea mays*
Cotton	*Gossypium hirsutum*
Grapes	*Vitis vinifera*
Hemp	*Cannabis sativa*
Lettuce	*Lactuca sativa*
Onion	*Allium cepa*
Pea	*Pisum sativum*
Soybean	*Glycine max*
Tobacco	*Nicotiana tabacum*

OTHER

The literature indicates that these hosts will permit complete cabbage moth development, but does not disclose all the conditions under which the host/pest relationship occurs.

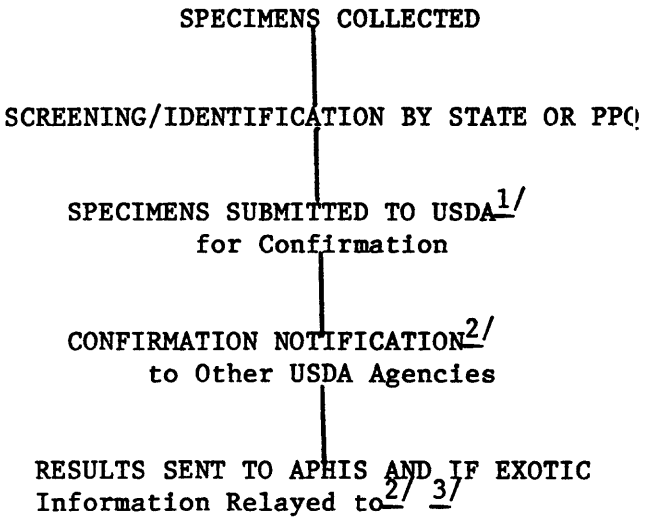
Common Name	Scientific Name
Alstromeria	*Alstromeria* spp.
Aztec tobacco	*Nicotiana rustica*
Bean	*Vigna* spp.
Birch (All)	*Betula* spp.
Bleeding heart	*Dicentra spectabilis*
Brussel sprout	*Brassica oleracea* var. *gemmifera*
Buckwheat	*Polygonum convolvulus*
Carrot	*Daucus carota*
Castor bean	*Ricinus communis*
Celery	*Apium graveolens* var. *dulce*

Chinese cabbage	*Brassica rapa* var. *pekinensis*
Chinese rhubarb	*Rheum palmatum*
Colville's glory	*Colvillea racemosa*
Cotton groundsel	*Senecia viscosus*
Dahlia	*Dahlia* spp.
Deadly nightshade	*Atropa belladonna*
Eggplant	*Solanum melongena*
Endive	*Cichorium endiva*
Fireweed	*Epilobium* spp.
Flax	*Linum usitatissimum*
Garlic	*Allium sativum*
Geranium	*Geranium* spp.
Gladiolus	*Gladiolus* spp.
Goldenrod	*Solidago* spp.
Knapweed	*Centaurea* spp.
Lamb's-quarters	*Chenopodium album*
Lupine	*Lupinus* spp.
Peanut	*Arachis hypogaea*
Peppermint	*Mentha X piperita*
Poppy opium	*Papaver somniferum*
Potato	*Solanum tuberosum*
Pot-Marigold	*Calendula officinalis*
Pyrethrums	*Pyrethrum* spp.
Rape	*Brassica rapa*
Redroot pigweed	*Amaranthus retroflexus*
Safflower	*Carthamus tinctorius*
Savory	*Satureja* spp.
Savoy cabbage	*Brassica oleracea* var. *bullata*
Sea-Lavender	*Limonium* spp.
Sesame	*Sesamum indicum*
Spirea	*Spiraea* spp.
Sunflower	*Helianthus annuus*
Tomato	*Lycopersicon esculentum*
Turnip	*Brassica rapa*
Vetch	*Vicia sativa*
Yellow sweetclover	*Melilotus officialis*

Addendum E--Identification of Specimens

As many specimens as possible of the pest are to be collected for identification by the local designated identifier. Suspect adult specimens should be forwarded dry in a small cardboard box and other stages in vials of alcohol for confirmation to 1/ below. These specimens must be accompanied by PPQ Form 391 marked "Urgent" (see PPQ Manual M390.500).

INFORMATION FLOW FOR THE IDENTIFICATION OF SPECIMENS



APHIS/ARS 1/	All States 2/	NAPPO 3/

1/ ARS — Insect Identification and Beneficial Insect Introduction Institute
Agricultural Research Service
U.S. Department of Agriculture
Building 476, BARC-EAST
Beltsville, Maryland 20705

APHIS — Plant Protection and Quarantine

2/ All States — State and Territory Agricultural Regulatory Officials

3/ NAPPO — North American Plant Protection Organization

Addendum F--Technical Application Data

1. BLACKLIGHT TRAP

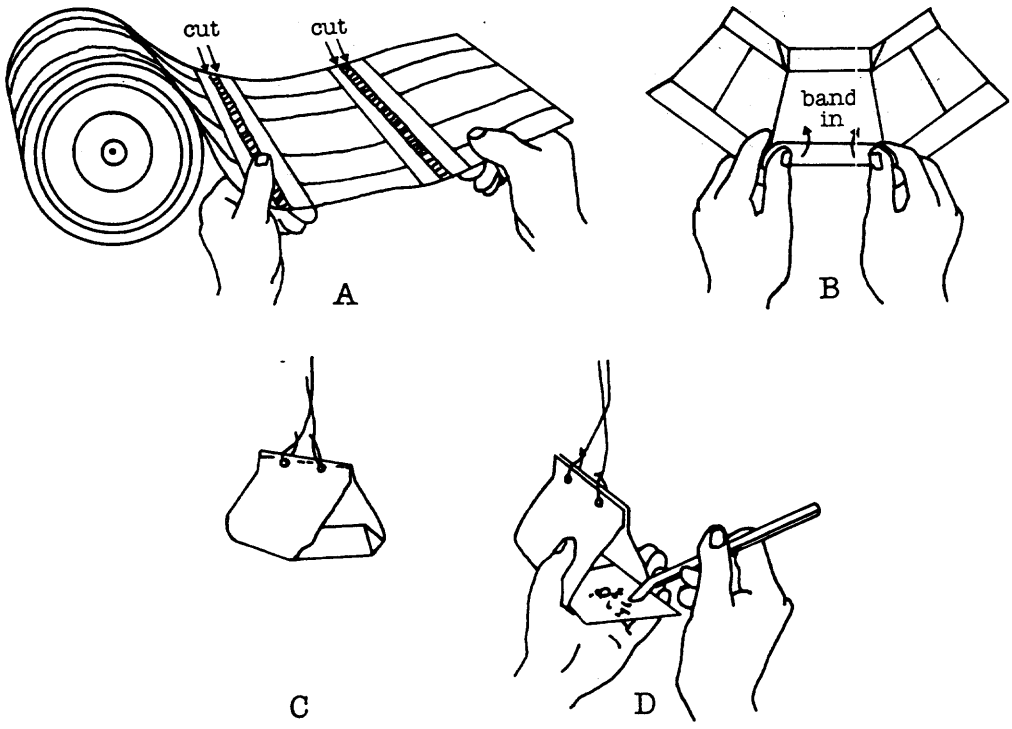
Blacklight traps commercially available from entomological supply companies may be used. Mercury vapor lamps may also be used.

As this system is labor intensive, it is to be employed only in the core and buffer areas in or near detections or where large numbers of hosts are found.

2. TETRA TRAP

The tetra trap is essentially a Delta trap with the top flaps left out. These traps are easily made from milk carton paper from 1-liter milk cartons. This paper can be purchased in 322-mm (12.7-inch) wide rolls from supply companies. One trap can be made from each section by bending along prescored lines to form a triangle with a base surface of 166 by 96 mm (6.5 by 3.8 inch) with just enough at the top stapled shut together with a wire hanger. The flaps are formed with a diagonal crease of each corner with the bottom flap bent inwards. Tanglefoot is used on the inside bottom.

Figure 2—Trap Construction



A polyethylene stopper of 10-mm diameter is installed in the trap. This is easily done by pushing a small thumbtack through the outside of the trap and pushing the stopper onto the tack on the inside. The stopper will have previously been injected by means of a microsyringe with 1 mg of 99.9 percent pure Z-11-hexadecenyl acetate.

The traps may be hung in the hosts where feasible (as in apple), but generally they should be about 1 to 1 1/2 m (3 to 5 feet) above the host.

3. SOIL SIEVING

A minimum 1-m (39-in) square, 15-cm (5.5-inch) deep sample of soil is to be dug out from under the selected host and placed in a suitable container such as a plastic garbage bag. The bag is labeled before transport.

Place soil sample in the top of a 4-mm (0.15-inch) sieve and wash down with water until all the lumps are broken and only solid objects remain in the sieve. Remove any solid objects, and collect the pupae.

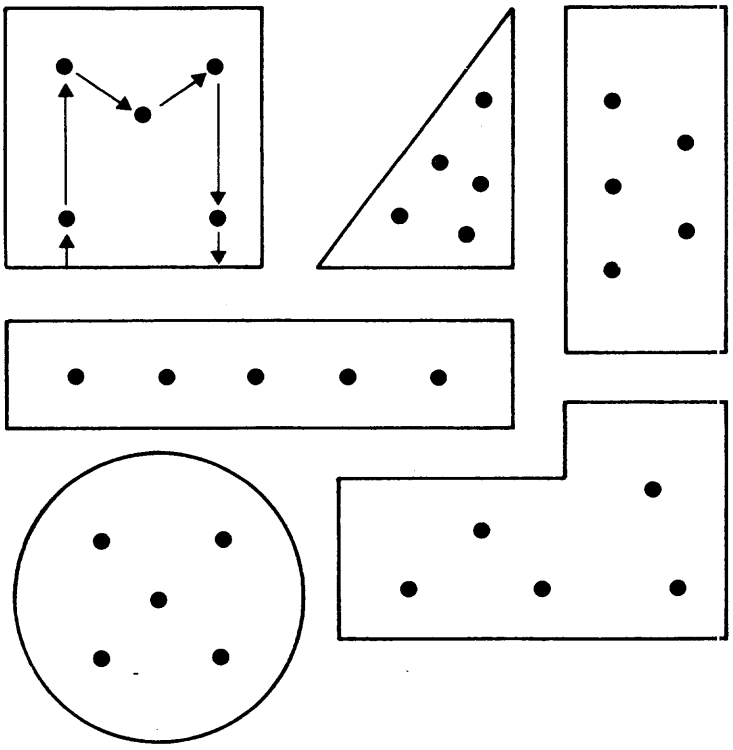
4. VISUAL SURVEY

Host fields with partly or completely eaten leaves or flowers, withered shoots, fallen stalks, fallen or rotting fruit, withered heads, or exhibit poor growth receive the first priority in the survey. Otherwise they should be equally spaced, with the exception of a bias towards the center of each find.

Sampling should follow a similar pattern for each field being surveyed. Sample field borders, fence rows or ditchbanks only when other hosts grow there. In this case, a separate sample may be taken, particularly if in a core area. Very large fields may need to be divided into smaller units, with each unit counted as a separate field of a maximum of 4 hectares (10 acres). Not all such units should be sampled at the same time, in order to keep spacing of sample fields roughly equal (except as given above).

When collecting samples within fields take samples from at least five different locations in the field. Move from site to site, following a predetermined pattern such as given below.

Field Survey Pattern



At each location, 50 plants from three adjoining rows should be inspected at random, with a bias towards those showing signs of partly or completely chewed leaves, poor growth, rotting, fallen fruit, holes in fruit or heads, withered shoots, or fallen stalks. The following should be investigated:

Eggs: Look for clusters of 15 to 200 plus of light-yellow to dark-brown eggs on the underside of leaves near growing points of the host.

Larvae: Check leaves and flowers first. Then look at fruit or heads for holes, telltale frass, or signs of decay. These and any stems and stalks with any obvious damage should be split.

Adults: Sometimes adults will be found on the underside of leaves, on back of trees, or flushed from herbaceous growth. These should be caught and destroyed or otherwise saved for identification.

If the infestation is heavy enough to warrant it, an estimate of the amount of infestation can be made. Another sample of 50 plants in the field can be taken, this time without bias towards unhealthy plants, so long as a given pattern is maintained, such as every fifth plant, up to three in a row in the first two rows, and four in the last row.

5. SOIL TREATMENT

Diazinon® 51.9 grams (g) (1.83 avoirdupois (av oz) active ingredient (a.i.) in enough water to soak 1 to 2 inches of soil over 1,000 sq ft to kill larvae and/or pupae and/or emergent adults. Apply the number of prescribed treatments at 14- to 16-day intervals as per specific exemption granted by the Environmental Protection Agency to all hosts on properties where larvae, pupae, and/or eggs have been found and environs within 200 m (216 yd) of find.

6. GROUND APPLICATION

The following pesticides may not be registered for use on a given crop. Any application inconsistent with product labeling must have prior approval. When eggs and significant numbers of newly hatched cabbage moth larvae are present, methomyl or chlordimeform should be employed as an ovicide, where possible.

Treatments should be in late afternoon or at night, when possible, as the kill rate is significantly higher than in daytime applications.

There is a chance of pesticide resistance in the introduced cabbage moth population. Such resistance has been demonstrated in various local populations from the Union of Soviet Socialist Republics for phoxim, endosulfan, and methyl parathion. In addition, there is cross resistance to methyl parathion plus endosulfan and to endosulfan plus phoxim. These specific pesticides are not among those listed below.

Older larvae may be, in general, more resistant and treatment with chlorpyrifos may be indicated.

Methomyl (Lannate® L)--302 g (10.65 av oz) a.i. of 24 percent methomyl in up to 378.5 L (100 gal) water per acre depending on type of equipment or 3.55 L (3 3/4 quarts (qt) 746 gms (26.3 av oz) a.i. in up to 935 L (247 gal) of water per hectare. Apply as a full coverage spray and repeat at 5- to 10-day intervals. An ovicide/larvicide should be applied when significant numbers of eggs and/or newly hatched larvae are present.

Trichlorfon (Dylox®)--0.6 to 0.89 L (20 to 30 oz) 454 to 680 g (16 to 24 av oz) a.i. of 80 percent trichlorfon in up to 378.5 L (100 gal) of water per acre depending on type of equipment or 1.5 to 2.2 L (49 to 74 oz) 1.12 to 1.7 kg (39.5 to 59.3 av oz) a.i. in 935 L (247 gal) of water per hectare. Apply as a spray when detections are made and, thereafter, approximately 15 days apart when larvae are present.

Chlorpyrifos (Lorsban® 4E)--0.95 to 2.6 L (2 to 5 1/2 pt) 0.45 to 1.25 kilograms (kg) (1 to 2.75 pounds (lb)) a.i. of 40.7 percent chlorpyrifos in 94.6 to 113.5 L (25 to 30 gal) of water per acre, depending on type of equipment or 2.3 to 6.4 L (4.9 to 12.3 pt) 1.1 to 3.1 kg (2.5 to 6.8 lb) a.i. in 234 to 280 L (61 to 74 gal) of water per hectare. Apply as a spray when detections are made and, thereafter, approximately 15 days apart when larvae are present.

Acephate (Orthene® 75S)--0.68 kg (1 1/2 lb) 0.51 kg (1.13 lb) a.i. of 75 percent acephate in 75.7 to 378.5 L (20 to 100 gal) of water per acre depending on type of equipment or 1.68 kg (3.7 lb) 1.26 kg (2.77 lb) a.i. in 187 to 935 L (49 to 247 gal) of water per hectare. Apply as a spray when detections are made and, thereafter, at 7- to 10-day intervals when larvae are present.

Carbaryl (Sevin® 50 W)--0.9 to 1.8 kg (2 to 4 lb) 0.45 to 0.9 kg (1 to 2 lb) a.i of 50 percent carbaryl in 11.4 to 151 L (3 to 40 gal) of water per acre depending on type of equipment or 2.2 to 4.4 kg (4.9 to 8.8 lb) 1.1 to 2.2 kg (2.45 to 4.4 lb) a.i. in 28 to 373 L (7.4 to 99 gal) of water per hectare. Apply as a spray when detections are made and, thereafter, at 7- to 14-day intervals when larvae are present.

7. AERIAL APPLICATION

The following pesticides may not be registered for this use on a given crop. Any application inconsistent with product labeling must have prior approval.

Trichlorfon (Dylox®)--0.6 to 0.89 L (20 to 30 oz) 454 to 680 g (16 to 24 av oz) a.i. of 80 percent trichlorfon in a minimum of 3.8 L (1 gal) of water per acre, depending on type of equipment and crop/host being sprayed or 1.5 to 2.2 L (49 to 74 oz) 1.12 to 1.7 kg (39.5 to 59.3 av oz) a.i. in a minimum of 9.5 L (2.5 gal) of water per hectare. Apply as a spray when detections are made and, thereafter, approximately 15 days apart when larvae are present.

Chlorpyrifos (Lorsban® 4E)--0.95 to 2.6 L (2 to 5 1/2 pt) 0.45 to 1.25 kg (1 to 2.75 lbs) a.i. of 40.7 percent chlorpyrifos in 7.6 to 18.9 L (2 to 5 gal) of water per acre, depending on type of equipment and crop/host being sprayed or 2.3 to 6.4 L (4.9 to 12.3 pt) 1.1 to 3.1 kg (2.5 to 6.8 lbs) a.i. in a minimum of 18.8 to 46.7 (4.9 to 2.4 gal) of water per hectare. Apply as a spray when detections are made and, thereafter, approximately 15 days apart when larvae are present.

Acephate (Orthene® 75S)--0.68 kgm (1 1/2 lb) 0.51 kg (1.13 lb) a.i. of 75 percent acephate in a minimum of 7.6 L (2 gal) of water per acre, depending on type of equipment and crop/host being sprayed or 1.68 kg (3.7 lb) 1.26 kg (2.77 lb) a.i. in a minimum of 18.8 L (4.9 gal) of water per hectare. Apply as a spray when detections are made and, thereafter, 7 to 10 days apart when caterpillars are present.

Carbaryl (Sevin® Sprayable)--1.1 kg (40 oz) 0.88 kg (2 lb) a.i. of 80 percent carbaryl in not less than 3.8 L (1 gal) of water per acre or 2.75 kg (100 oz) 2.2 kg (5 lb) a.i. in not less then 9.5 L (2.5 gal) of water per hectare. Apply as a spray when detections are made and thereafter, approxmiately 5 to 10 days apart.

Methomyl (Lannate® L)--1.4 L (1 1/2 qt) 302 g (10.65 av oz) a.i. of 24 percent methomyl in a minimum of 18.9 L (5 gal) of water per acre, depending on type of equipment and crop/host being sprayed or 3.55 L (3 3/4 qt) 746 g (26.3 av oz) a.i. in a minimum of 12.5 gal of water per hectare. Apply as a spray and repeat at 5- to 10-day intervals. An ovicide/larvicide best applied when significant numbers of eggs and newly hatched larvae are present.

8. SANITATION

Sanitation will consist of the following measures to be applied depending on the circumstances and equipment available.

a. Plowing of Fields: If the infested area is relatively small or a given field is heavily infested, this measure should be highly effective for annual hosts. The host material is plowed or dug up in excess of 15 cm (5.91 in) and collected for disposal (7c, d, and e).

b. Cleaning: Hosts may be effectively stripped of a fallen, rotten, punctured, decaying, or otherwise unhealthy heads, leaves, fruit, berries or vegetables, and any visible larvae or adults flushed from hiding are destroyed. Host material will then be disposed as in (8c, d, and e).

c. Buring of Debris: When host material is collected, it may be piled into heaps and burned. The residue can then be disked under or otherwise buried in an approved landfill.

d. Animal Food: Host material may be used as animal food. Any residue will be disposed of by burning and burial or burial at and approved landfill.

e. Bagged and Buried: Host material may be collected in suitable containers and transported to an approved landfill.

Addendum G--Forms

To be added later.

Addendum H--Contributors

Industry

D. Stapell, Manager, Information Services, United Fresh Fruit and Vegetable Association, Alexandria, Virginia

State Regulatory Officials

J. Dreves, Director, Plant Industry Division, Michigan Department of Agriculture, Lansing, Michigan

G. Karr, Plant Pathologist, Plant Industry, Alabama Department of Agriculture and Industries, Montgomery, Alabama

K. Roach, Specialist in Charge, Division of Plant Industry, Ohio Department of Agriculture, Reynoldsburg, Ohio

University

R. B. Chalfant, Professor, Department of Entomology, Georgia Coastal Plain Experiment Station, University of Georgia, Tifton, Georgia

S. R. Race, Professor, Department of Entomology, Cook College, New Brunswick, New Jersey

Governmental Agencies

R. L. Cowden, Senior Staff Officer, Survey and Emergency Response Staff, National Program Planning Staff, Plant Protection and Quarantine, Animal and Plant Health Inspection Service, U.S. Department of Agriculture, Hyattsville, Maryland

C. S. Creighton, Research Entomology, Vegetable Insects Research, Agricultural Research Service, U.S. Department of Agriculture, Charleston, South Carolina

B. Glen Lee, Assistant Director, Survey and Emergency Response Staff, National Program Planning Staff, Plant Protection and Quarantine, Animal and Plant Health Inspection Service, Hyattsville, Maryland

J. N. L. Stibick, Staff Entomologist, Survey and Emergency Response Staff, National Program Planning Staff, Plant Protection and Quarantine, Animal and Plant Health Inspection Service, U.S. Department of Agriculture, Hyattsville Maryland

Addendum I--References

The literature on cabbage moth is quite extensive. Articles relevant to this Action Plan are listed here. Little work seems to have been carried out on sterile insects, but there is a somewhat respectable number of papers on parasites.

Baicu, T.; Stefan, A.; and Ionescu, M., 1971. Actiunea carbarilului si fennitrotionului asupra plantei de varza si eficacitatea lor in conbaterea insectei Mamestra brassicae L. Inst. Cercet. Pentru. Prot. Platn. An. 7:267-275.

Balachowsky, A. and Mesnil, L., 1936. Les insectes nuisibles aux plantes cultivees. Lib. Sci. nat., Paris 2(4):1189-1192.

Bonnemaison, M. L., 1972. Action de la photophase et de la scotophase sur la diapause de Mamestra brassicae L. C. R. Acad. Sc. Paris, Ser. D, 274 (24):3280-3282.

_____1973. Action de la photoperiode sur la diapause de Mamestra brassicae L. C. R. Acad. Sc. Paris, Ser. D, 277(2):213-216

_____1973. Hypothese relative a la determination de la diapause sous l'action de la photoperiode chez Mamestra brassicae L. C. R. Acad. Sc. Paris, Ser.D, 277(8): 729-732.

Borcan, I., 1978. Combaterea la avertizare a buhei verzei (Mamestra brassicae L.). Productia vegatala-Horticultura 27(8):13-16.

Burov, V. N. and Mokrousova, Ye. P., 1970. The regulatory role of insect population density as exemplified by the cabbage moth, Barathra brassicae L. Ent. Rev. 49(2): 147-150.

Ciampolini, M. and Zangheri, S., 1977/1978. Gravi e tipici danni di Mamestra brassicae L. alle coltivazioni di Cavolo broccolo nel Foggiano. Boll. Zool. Agr. Bachic. Ser.II, 14:173-179.

Descoins, C.; Priesner, E.; Gallois, M.; Arn, H.; and Martin, G., 1978. Sur la secretion pheromonale des femelles vierges de Mamestra brassicae L. et de Mamestra oleracea L. C. R. Acad. Sc. Paris, Ser D, 286(1):77-80.

Dochkova, B., 1972. Some ecological studies on Mamestra brassicae L. Gradinarska Lozarska Nauk. 9(1):77-86.

Fukamachi, S., 1978. Phenology of the cabbage moth, Mamestra brassicae L. in Kagoshima. Ho. Proc. Assoc. Pl. Prot. Kyushu, 24:112-114.

Fukamachi, S.; Masaki, S.; Hashimoto, Y; and Suzuki, M., 1982. Diapause responses to photoperiod and night interruption in Mamestra brassicae Appl. Ent. Zool., 17(3):398-409.

Gerasimov, B. A. and Osnirskaya, E. A., 1960. Pests and diseases of vegetable crops. Israel Prog. Sci. Pub., 15:27.

Giovanni, G.; Brunelli, A.; and Ponti, I., 1973. Prove di litta contro la Mamestra brassicae L. Ital. Agr. 110(1):117-126.

Goryshin, N. I. and Tyshchenko, G. F., 1973. Accumulation of photoperiodic information during diapause induction in the cabbage moth Barathra brassicae L. Entomol. Rev. 52(2):173-176.

Goryshin, N. I.; Tyshchenko, G. F.; and Saulich, A. H., 1982. A study of seasonal adaptations in the homodnamie Lepidoptera. Zoolog. Zhurmal, 61(1):36-46.

Hirai, K., 1977. Observations on the function of male scent brushes and mating behavior in Leucania separata W. and Mamestra brassicae L. Appl. Ent. Zool. 12(4): 347-351.

Inoue, H., 1977. Effectiveness of acephate against the Lepidopterous insects on potato. Proc. Assoc. Pl. Prot. Kyushu, 23:125-136.

Kammer, D., 1977. Untersuchungen zur insektizidempfindlichkeit in korrelation zur 24-stunden-periodik an Larven von Mamestra brassicae L. Biol. Zbl. 96(1):33-41.

Ledieu, M. S., 1978. Candidate insecticides for the control of larvae of Mamestra brassicae. Ann. appl. Biol., 88(2(:251-255.

Lempke, B. J., 1975. Opvallende voedselplant voor Mamestra brassicae L., Entomol. Ber. 35(7):102.

Maceljski, M.; Camprag, D.; and Stankovic, A., 1972. Ispitivanja mogucnosti suzbijanja gusjenica lisnih sovica no secernoj repi. Savremena Poljoprivreda, 20(2):53-67.

Ogard, L., 1983. Kaluglen (Mamestra brassicae L.). Udviklingsmuligheder i Danmark belyst ved simpel simulation. Ent. Meddr. 50(1):36-46.

Oku, T. and Kobayashi, T., 1973-1974. Some dynamic aspects of field populations of the cabbage armyworm, Mamestra brassicae Linne in Tohoku district. I-VII. Bull. Tohoku Nat. Agr. Exp. Sta. 44:97-108; Kontyu, 41:267-279; Bull. Tohoku Nat. Agr. Exp. Sta. 47:133-195.

Oku, T. and Kobayashi, T., 1973. Some dynamic aspects of field populations of the cabbage armyworm, Mamestra brassicae Linne in Tohoku district. I. Bull. Tohoku Nat. Agr. Exp. Sta. 44:97-108.

_____1973. Some dynamic aspects of field populations of the cabbage armyworm, Mamestra brassicae Linne in Tohoku district. II. Kontyu 41:267-279.

_____1974. Some dynamic aspects of field populations of the cabbage armyworm, Mamestra brassicae Linne in Tohoku district. III-VII. Bull. Tohoku Nat. Agr. Exp. Sta. 47:133-195.

Omino, T., 1973. Experimental studies on the daytime behavior of noctuid larvae, the cabbage armyworm, the tobacco cutworm, and the black cutworm. Jap. J. Appl. Entomol. Zool. 17(4):215-220.

Paddock, E., 1978. Cabbage moth. State of California, Department of Food and Agriculture, Division of Plant Industry, Exclusion and Detection, Detection Manual D. T. 3:62.

Poitout, S., 1978. The cabbage moth: Developmental cycle, favorable periods for chemical interventions. La Defense des Vegetaux, 32(193) 186-197.

Poitout, M. M. S. and Bues, R., 1973. Mise en evidence d'une diapause nymkphale de type estival dans des populations europeenas de deux Lepidopteres Noctuidae Hadeninae (Mamestra oleracea at Mamestra brassicae L.). C. R. Acad. SC. Paris, ser. 276(25):3367-3370.

_____1977. Etudes comparees des diapauses nymphales estivales existant dans les populations de basse vallee du Rhone de deux Noctiudae Hadeninae(Mamestra brassicae L., Mamestra oleracea L.). Ann. Zool. Ecol. Anim. 9(2):225-234.

_____1977. Quelques aspects genetiques de l'heterogeneite de manifestation de la diapause estivale dans les populations europeenes de deux Lepidopteres Noctuidae Hadeninae (Mamestra oleracea L. et Mamestra brassicae L.). Ann. Zool. Ecol. Anim. 9(2):235-259.

Poitout, S. and Bues, R., 1982. Les principales noctuelles nuisibles. Phytoma-Defense des Cultures, 337:39-43.

Popov, P., 1977. Mamestra brassicae, a new pest of grapevine in this country. Lozar Vinar 26(2):18-21.

Rauscher, S.; Arn, H.; and Schmid, A., 1979. Sex attractant formulations and traps for the grape moth Eupoecilia ambiquella Hb. Bull. Soc. Entomol. Suisse, 52:49-55.

Rygg, T. and Kjos, O., 1975. Kalfly (Mamestra brassicae L.). Noen undersokelser over dets biologi og bekjempelse. Gartneryket 65(16):286-290.

Salem, A. A., 1976. Role of spectral composition of light in photoperiodism of insects. 2. Spectra characteristics of photoperiodism receptors of the cabbage moth. Zool. Zh. 45(10):1482-1488.

Samedov, A. N., 1978. Diurnal rhythm of feeding and gas exchange in the cabbage moth (Baratha brassicae L.). Soviet J. Ecology 19(3):278-281.

Sato, K. and Suwanai, M., 1976. Studies on the toxic effect of insecticides on insects. I. An empirical equation for the applied dose and the lethal time of several insectides against the various instar larvae of the cabbage armyworm, Mamestra L. Botyu-Kagaku, 41(3):112-134.

Setokuchi, O. and Tanaka, A., 1980. Trivoltine cycle of the cabbage moth, Mamestra brassicae (Linne) in Kagoshima prefecture. Jap. J. Appl. Ent. Zool. 24(2):114-117.

Simonenko, N. P., 1978. The special nature of seasonal changes in the development of the cabbage moth Barathra brassicae continuously reared in the laboratory. Entomol. Review 57(3):323-327.

Straka, F., 1974. Altersbedingte veranderungen in der resistenz der raupen einiger noctuidenarten gegen die Kontaktwirkung von thiodan 35 EC. C. R. Acad. Agric. G. Dimitrov, 7(3):27-30.

_____1978. Studies on the resistance of Mamestra brassicae to some insecticides in different regions of Bulgaria. Rast. nauki. Plant Science 15(6):123-129.

Struble, D. L., 1980. Identification of 4 sex pheromone components isolated from calling females of Mamestra brassicae. Zeit fur Natur. Section C. V. 35 (1/2): 45-48.

Subchev, M., 1978. Pheromone traps for the cabbage moth. Plant Protection 26(7): 33-34.

Subchev, M. A., 1980. Calling behavior of female cabbage moths (Mamestra brassicae L.). Ekologiia, 7:33-38.

Szentesi, A.; Toth, M.; and Dobrovolszky, A., 1975. Evidence and preliminary investigations on a male aphrodisiac and a female sex pheromone in Mamestra brassicae L. Acta Phytopathol. 10(314):425-429.

Tassan, R. L.; Hagen, K. S.; Cheng, A.; Palmer, T. K.; Feliciano, G.; and Blough, T. L., 1982. Mediterranean fruit fly life cycle limitations for the California eradication program. Fruit flies of economic importance. Commission of the European Communities, International Organization for Biological Control. pp.565-570.

Toth, M., 1982. Male produced pheromone of Mamestra brassiae L., its possible role in courtship behavior and study of other effects. Acta Phytopathol. 17(1/2): 123-132.

Voigt, E., 1974. Schadigungen an Reben in Ungarn durch die Raupen der Kohleule (Mamestra brassicae L.). Weinburg und Keller, 21(6):281-288.

Yokoi, S.; Omino, T.; and Tsuji, H., 1975. Experimental studies on behavioral differences among three noctuid species larvae and Spodoptera litura in relation to the efficacy of a commercial bait. Jap. J. Appl. Entomol. Zool. 19(1):11-16.

Yokoi, S. and Tsuji, H., 1975. Experimental studies on the movement behavior of the final instar noctuid larvae of the cabbage armyworm and the tobacco cutworm. Jap. J. Appl. Entomol. Zool. 19(3):157-161.